QMBox10 series devices:
QMBox10-16, QMBox10-32, QMBox10-48, QMBox10-128
Technical Description and User Manual.
Revision 2.1.

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1. General information

The QMBox10 series devices are multichannel ADCs with USB 2.0 interface. Depending on their model, the devices may feature 16 to 128 differential analog inputs or from 32 to 256 single-ended analog inputs.

The devices of QMBox20 series are designed for analog-to-digital conversion of signals with **0...200 kHz** spectrum components. The devices may be used as multichannel oscilloscopes, spectrum analyzers, as well as full-fledged data recorders with indefinite continuous data storage on PC.

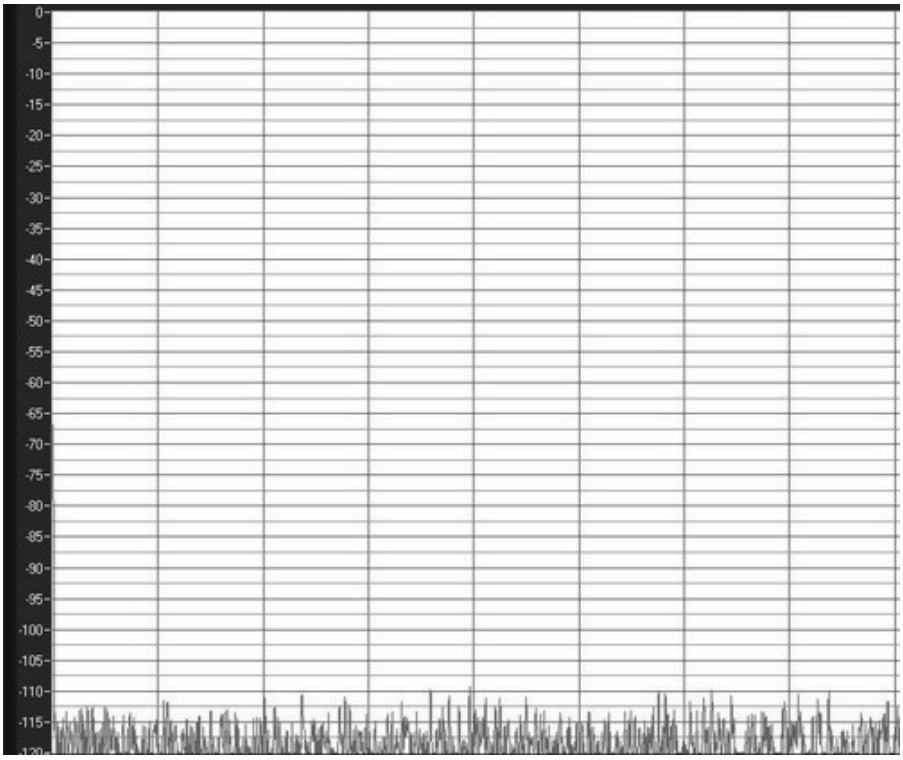
Features

- Minimal “cost / number of channels” ratio alongside with the excellent metrological characteristics;
- Single-ended input mode permits doubling the number of channels when the use of differential inputs is not required;
- Communication with PC provides a possibility of simultaneous acquisition, visualization and storage of data without gaps or recording time limits;
- Free PC software (Windows OS) is sufficient to operate the device without any additional calibration or programming.

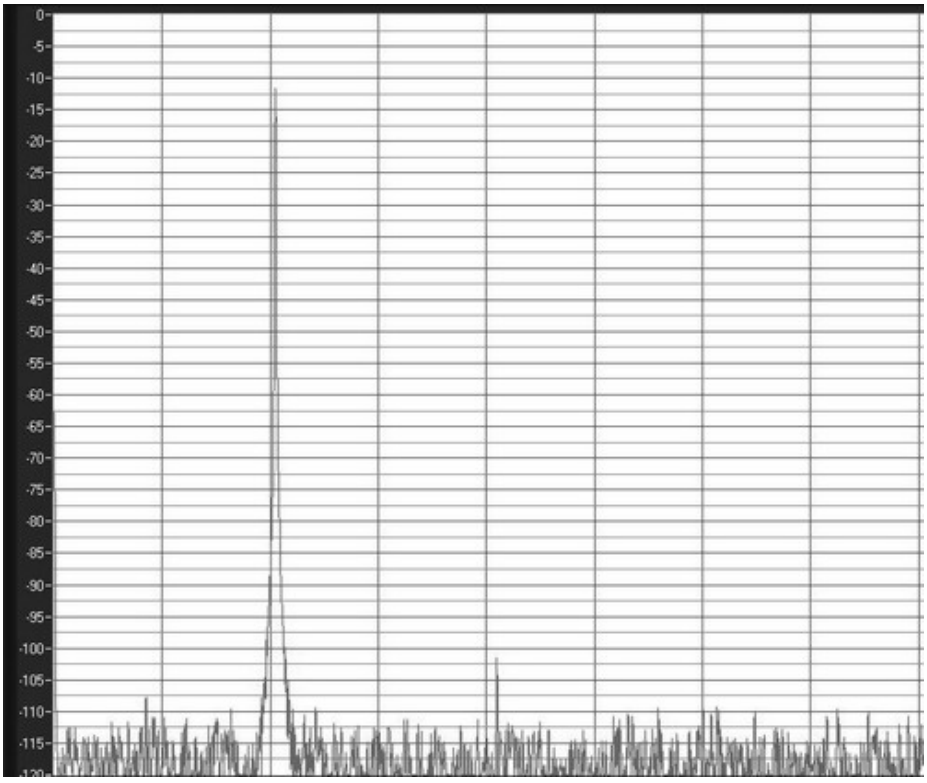
2. Specifications

Model	**QMBox10-16**	**QMBox10-32**	**QMBox10-48**	**QMBox10-128**
Number of input channels	**16** differential / **32** single-ended	**32** differential / **64** single-ended	**48** differential / **96** single-ended	**64 to 128** differential / **128 to 256** single-ended
Design				
Input signal range (programmable per channel)	± 10 V; ± 2.5 V, ± 0.625 V, ± 0.156 V			
Max. aggregate throughput (all channels)	**0.4 MS/s**	**0.8 MS/s**	**1.2 MS/s**	**1.6 – 3.2 MS/s**
Max. sampling rate (one channel)	0.4 MS/s			
ADC resolution	14 bits			
Sensitivity - at input range ± 2.5 V	0.7 mV			
Reference limiting error	0.05 %			
Typical common-mode rejection ratio (input signal 5 V, 10 kHz)	-75 dB			
Typical crosstalk (for input signal 10 kHz with channel switching frequency 100 kHz at input ranges ± 10 V; ± 2.5 V, ±0.625 V)	-83 dB			
Input overvoltage protection: - Permanent overvoltage (10 sec) - Impulse (1 ms)	±15 V ±50 V			
PC interface	USB 2.0			
Power supply	100–240 V AC or 24 V DC			
External environment	from +5°C up to +55°C with relative moisture from 5% up to 90%			
Dimensions, mm	140x190x40	140x190x60	140x190x80	260x260x160

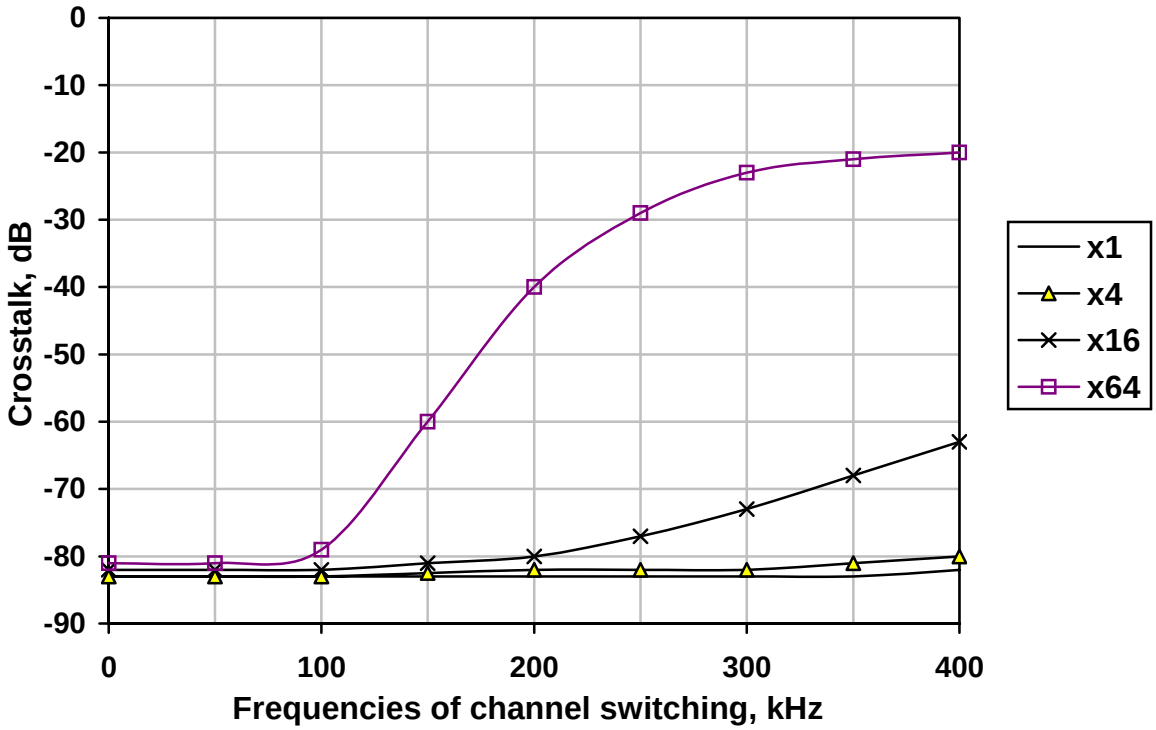
Figures below show typical characteristics of a QMBox10 device: Harmonic distortion; noise in the ½ f_{ADC} band; the graph of Crosstalk dependency towards channel switching frequency.



Noise in the ½ f_{ADC} band (f_{ADC} = 400 kHz)



Harmonic distortion. Input signal - sine-wave 10 kHz, 3V. f_{ADC} = 400 kHz.



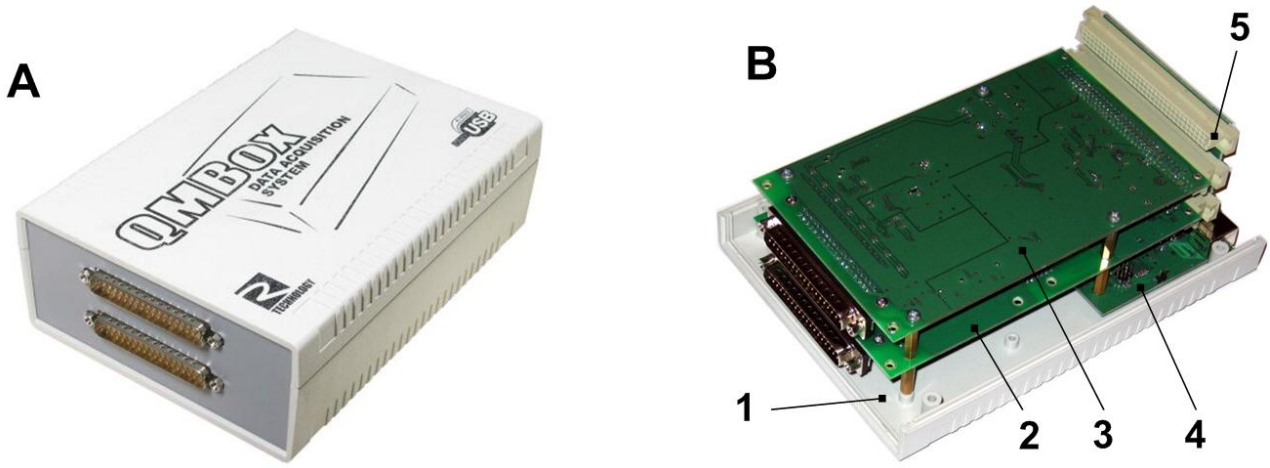
Crosstalk dependency towards channel switching frequency.

3. Architecture

The basic components of QMBox10 devices are 16-channel **QMS10** ADC modules that are installed into one case. Depending on the number of modules installed, a QMBox10 device can have 1-, 2-, 3- or 8-module configurations, thus, different models of the device differ in the number of input channels.

Model	**QMBox10-16**	**QMBox10-32**	**QMBox10-48**	**QMBox10-128**
Number of the QMS10 modules installed	**1**	**2**	**3**	**4 to 8**
Number of input channels (diff. / single ended)	16/32	32/64	48/96	64/128 to 128/256
Dimensions	140x190x40 mm	140x190x60 mm	140x190x80 mm	260x260x160 mm

The two-module device QMBox10-32 is used to demonstrate QMBox10 internal construction:



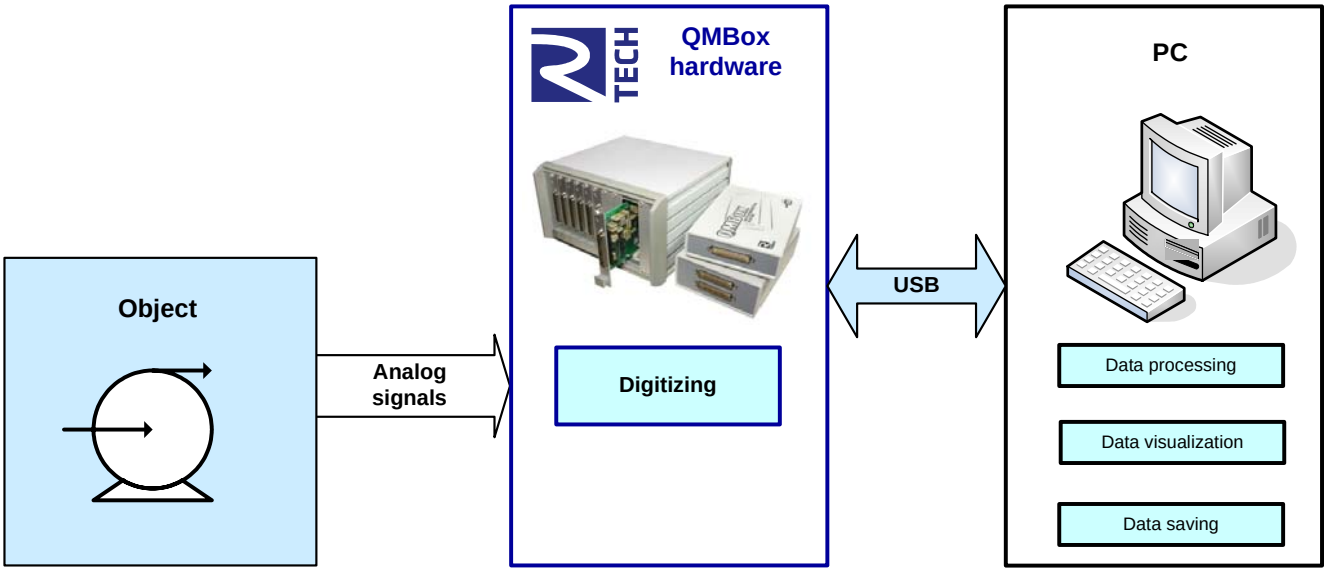
A – the assembled device; B – the same device with the cover removed;
1 – Bottom shell
2, 3 – QMS10 ADC modules – 2 pieces
4 – Interface board that controls operation of the modules and ensures connection of the device to the computer via USB
5 – Interconnect board that ensures electric connection of the modules to the interface board.

Inside the case the QMS10 modules are plugged into the slots of the interconnect board. This board joins the modules into a single device and ensures electric connection of the modules to the interface USB board. The interface board controls operation of the modules and ensures connection of the device to the PC via USB.

This scalable modular architecture allows to combine modules of different types (ADC, DAC, Discrete I/O, etc.) in a single device. These modules can be combined in one device in any configuration. For detailed information about Combined devices, see
http://www.rtechelectronics.com/products/qmbox/index.php

4. Principle of operation

The QMBox10 series devices operate under PC control (OS Windows) via USB connection. The software supplied with QMBox10 devices performs stream input of data from the ADC to the PC memory, its processing and further visualization on the display as well as saving to the PC hard disk:



Before starting work the configuration is performed by means of the software – the operation parameters of the device are set: sampling rate, the number of channels in use, etc.[1]

After this the device is started, i.e. the data transfer session is launched.

During the data transfer session the QMBox10 device digitizes input analog signals at a preset rate and sends the data through the interface board to the computer via USB. In the PC the data is put to a circular buffer in RAM. During the buffer filling, the data is taken from it by the application software for further processing, visualization and saving to the hard disk. Since the software takes data from the buffer at a rate higher than the rate of its receipt from the device, the data transfer session can last for however long, and data from the device is received by the computer without gaps. Thus, the device can be used as a full-fledged data recorder without record time limits.

[1] It should be taken into consideration that the overall rate of all the channels in use cannot be arbitrarily high. For example, the “Max aggregate throughput” parameter of the QMBox10-48 device = 1.2 MS/s (see Technical Specifications). This means that one can use all the 48 channels of the device with the sampling rate not higher than (1.2 / 48) = 25 kHz; or 6 channels with the rate not higher than (1.2 / 6) = 200 kHz; or 3 channels with the maximum possible rate (1.2 / 3) = 400 kHz.

5. Acquisition synchronization

All the modules installed in the device are clocked by the same generator on the interface board. That is why in the course of work the modules of the device are precisely synchronised with each other.

However, sometimes it is necessary not only to synchronize the modules with each other, but to precisely time the entire device to be started by a certain external event.

By default the device starts the acquisition since after issuing the command “Start” from a PC. This command can be executed within a few milliseconds. The exact execution time of this command under OS Windows (that is not a real-time OS) is impossible to be learnt in advance. For the cases when it is necessary to bind the start of the data acquisition to any external event with high precision one can use the external start synchronization mode. In this mode for the beginning of the acquisition after the issuing the “Start” command it is necessary to give a negative digital pulse (logical “1” - “0” - “1”) to the "SYN" contact of the device. The data acquisition begins right after negative pulse edge (logical “1” to “0”) arrives. The duration of the SYN pulse (i.e. of the logic “0”) must be at least 50 ns. The “SYN” line has an internal pull-up resistor, so one can just short the “SYN” line to “ground” to generate the required pulse.

Switching between start synchronization modes of data acquisition is software-selectable.

6. Connecting the device

The figure shows the rear panel of a QMBox10 device:

“Link” LED — turns on when the device is connected to USB and signals that the USB port of the computer has identified the device correctly.

USB port — type B. A standard connector for connecting the device to the PC via USB with an standard USB A-B cable.

Power Supply Port — it is used for supplying power from an external supply included in the delivery set.

The procedure of connecting the QMBox series devices is as follows:

1. Connect the power supply from the delivery set of the device to the Power Supply Port of the device.
2. Connect the power supply from the delivery set of the device to AC network.
3. Connect the device to the PC via a USB cable. At this the “Link” LED should turn on. When the device is connected for the first time, driver installation might be required. For further information see Connecting the device to the PC for the first time.
4. Connect the signal sources to the device — see Connecting to the object.

The procedure of disconnecting the the QMBox series devices is as follows:

1. Disconnect the object (signal sources) from the device.
2. Disconnect the device from the PC.
3. Disconnect the power supply from the AC network.
4. Disconnect the power supply from the device.

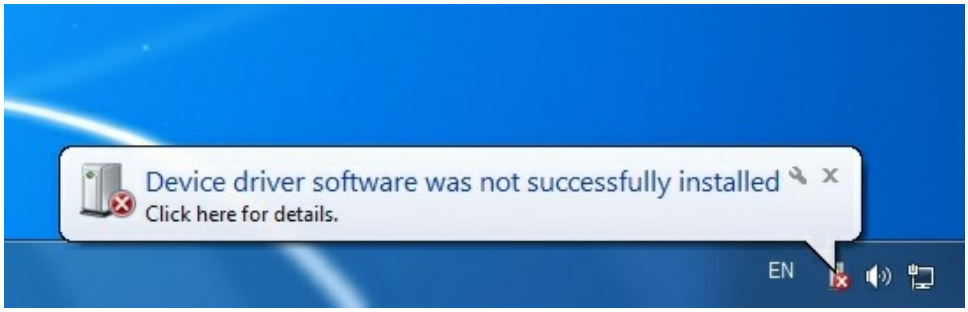
6.1. Connecting the device to the PC for the first time

When the QMBox series device is connected to a Windows PC for the first time, it is necessary to specify the location of the device driver.

Before connecting the device to the PC for the first time you should first insert the included CD into the CD-ROM drive of your PC and only then connect the device to the PC via a USB cable.

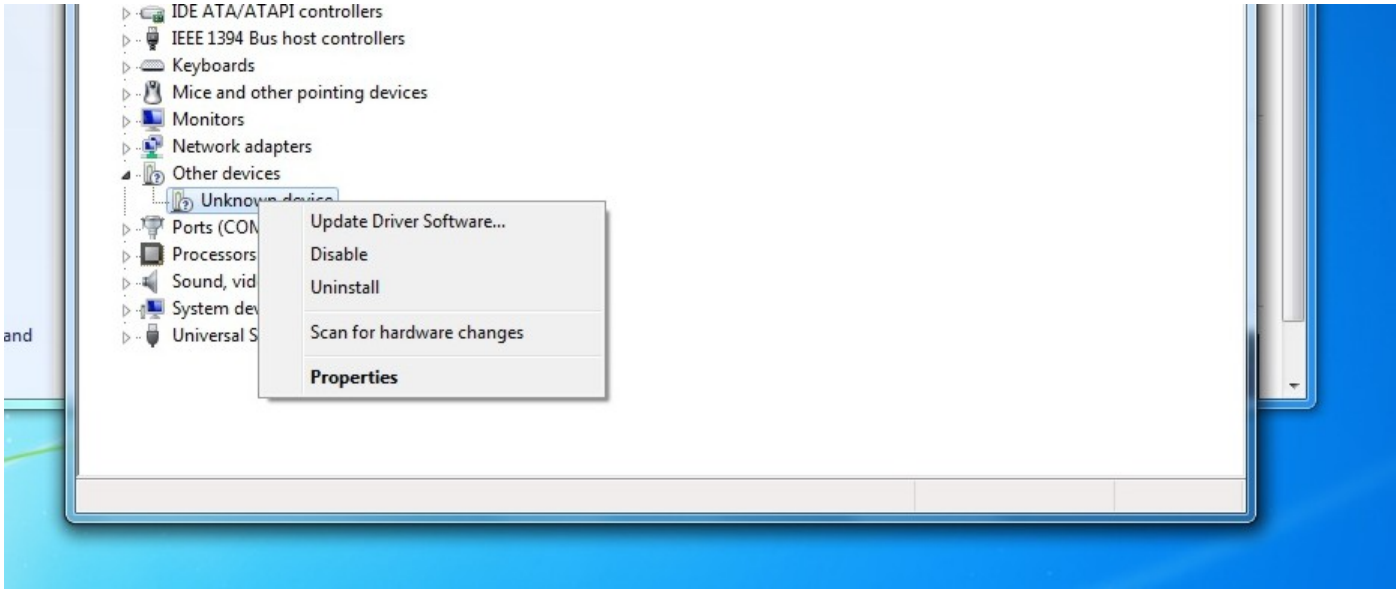
As a rule, having detected a new device, Windows starts the Found New Hardware Wizard. In this case you should follow its instructions, choosing not to go to the Windows Update site and specifying the “\DRV” folder on the included CD as the location of the driver.

Windows might not start the Found New Hardware Wizard automatically, returning a driver error message in the notification area (in the right bottom corner of the screen):

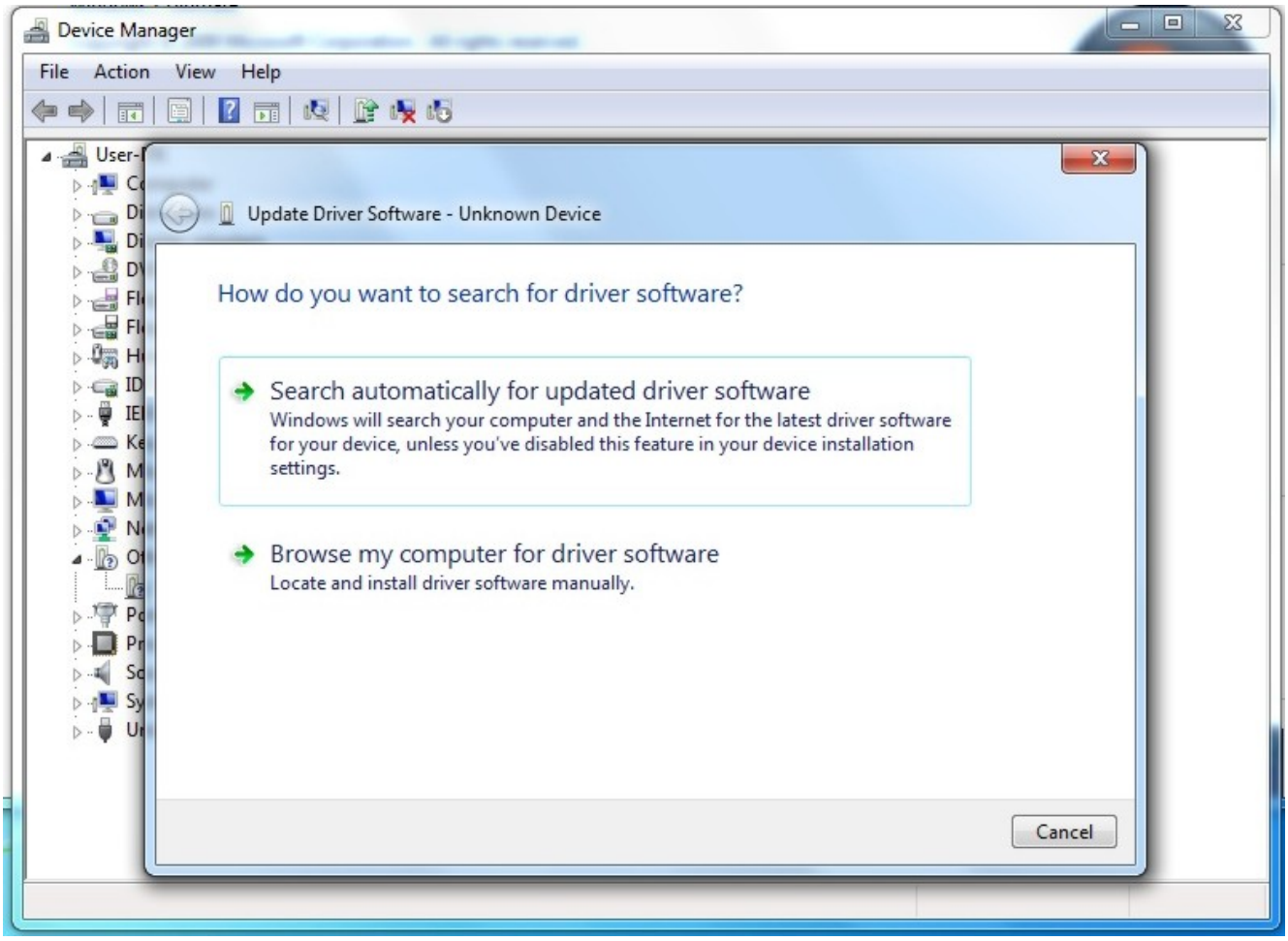


In this case you should start the Device Manager. In different Windows OS versions the Device Manager is started differently. For example, in Windows 7 it can be started by right-clicking the Computer icon, then – Properties, and then – Device Manager.

In the Device Manager QMBox device will appear as Unknown device. You should right-click on it and select “Update Driver Software”:

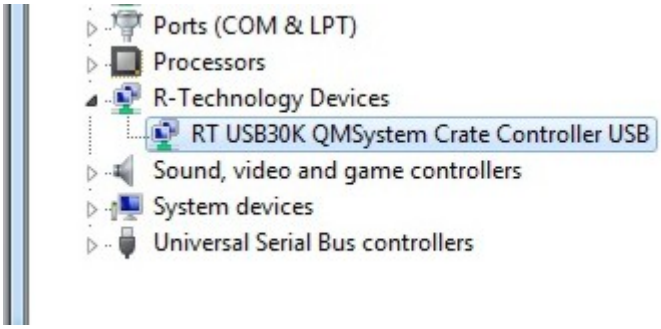


After this the Found New Hardware Wizard will start up:


Device Manager
File Action View Help
Update Driver Software - Unknown Device
How do you want to search for driver software?
Search automatically for updated driver software
Windows will search your computer and the Internet for the latest driver software for your device, unless you've disabled this feature in your device installation settings.
Browse my computer for driver software
Locate and install driver software manually.
Cancel

You should select “Browse my computer for driver software” and specify the “\DRV” folder on the included CD as the location of the driver.

Then you should follow the instructions of the Wizard. Once the driver is successfully installed, the “RT USB30K QMSystem Crate Controller USB” device should appear in the Device Manager:

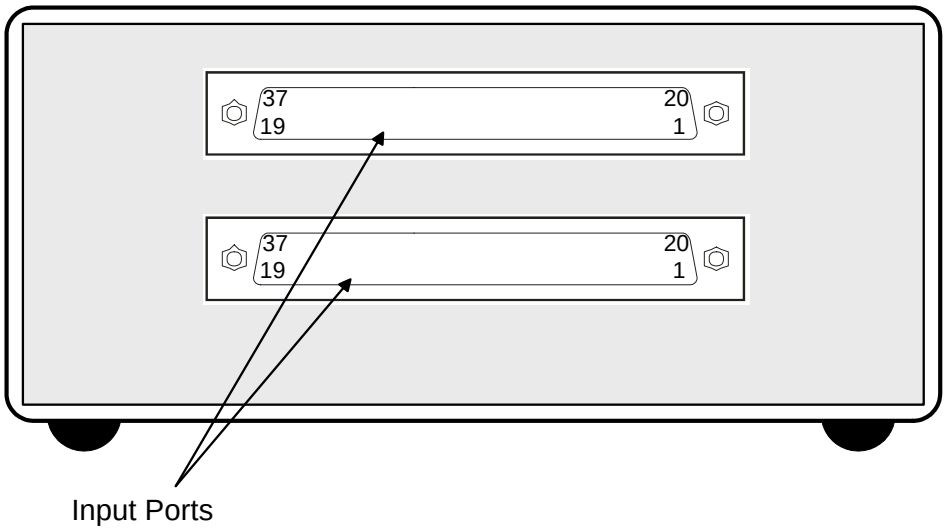


This means that the device’s Interface board has been identified correctly by the PC, the driver is installed and the device is ready to work.

Afterwards, when the QMBox device is connected to another USB port of the PC, Windows might once again detect the QMBox device as “unknown device”. In this case you will have to repeat the driver installation procedure as described above.

6.2. Connecting to the object

The figure shows the front panel of a QMBox10 device (QMBox10-32 model, consists of 2 QMS10 modules):



Every QMS10 module which is a part of the QMBox10 device has its own input port for the signals connection.

The input port of the QMS10 module is described in the table, where **Xn** —non-inverting, and **Yn** — inverting inputs of the differential channel **n**; NC — the pin is reserved.

Pin num.	Description	Pin num.	Description
1	**+15 V** (analog supply) output	20	**SYN** – synchronization input[2]
2	**-15 V** (analog supply) output	21	**AGND32**–ground for single-ended mode
3	**AGND** – Analog ground [3]	22	X16 input
4	Y16 input	23	X15 input
5	Y15 input	24	X14 input
6	Y14 input	25	X13 input
7	Y13 input	26	X12 input
8	Y12 input	27	X11 input
9	Y11 input	28	X10 input
10	Y10 input	29	X9 input
11	Y9 input	30	X8 input
12	Y8 input	31	X7 input
13	Y7 input	32	X6 input
14	Y6 input	33	X5 input
15	Y5 input	34	X4 input
16	Y4 input	35	X3 input
17	Y3 input	36	X2 input
18	Y2 input	37	X1 input
19	Y1 input		

[2] See Acquisition synchronization. Allowable potential on the SYN input is 0… 3,5 V relative to the ground (contacts 11, 28).

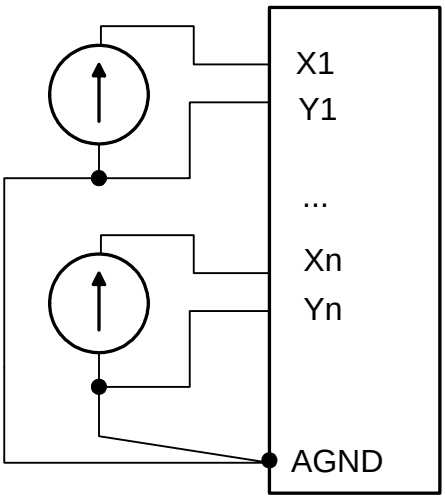
[3] Analog ground is connected to USB ground inside the device.

The correct connection of the sources of analog signal is the most important condition of the correct operation of acquisition system which allows to avoid a lot of problems during the device operation. During the connection of the sources of analog signal to the device it is necessary to keep to the following recommendations:

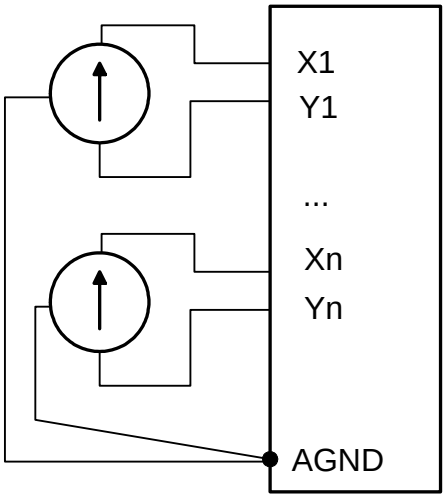
1. Differential connection presupposes measuring voltage difference between the inverting and non-inverting inputs of the channel, i.e. differential voltage. However, it is necessary to remember that **the voltage in relation to the analog ground of the device on both inputs (common-mode voltage) should not be higher than the acceptable input signal range**.
2. Correct connection of a signal to the differential input is always a **three-wire connection**. It is necessary to separate signal wires connected to a high-impedance input from the common ground wire. Thus, circuit of high current through signal wires, which reduces measurement accuracy, is eliminated.
3. When several signal sources are connected to the device, it is advisable that their common wires connect **at one point only**, on the **AGND** pin of the input port. This will eliminate formation of “ground loops” that are a source of extra noise.
4. The unused analog inputs should be grounded — i.e. just to be connected with AGND pins of the input port. Unused digital inputs could be left disconnected.

On the scheme there are the examples of the correct connection of 1-phase and 2-phase (differential) signal sources to the device. Note that even single-phase signal sources should be connected to a differential input with three wires!

The single-phase signal sources



The differential signal sources

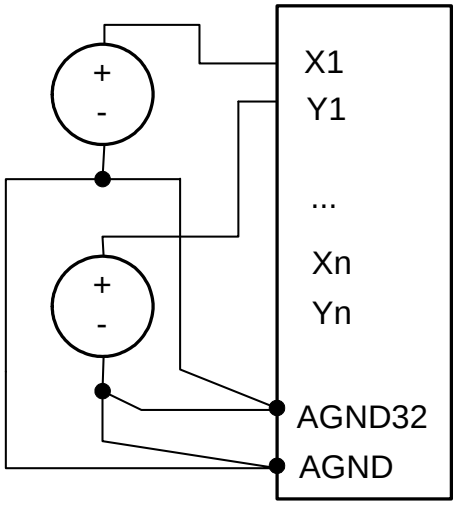


Differential connection of a signal source reduces the level of common-mode noise. Besides, differential inputs allow connecting signal sources so that currents of signal circuits do not flow through a single wire, which increases measurement accuracy.

Single-ended input mode permits doubling the number of channels when the use of differential inputs is not required.

On the scheme there is the example of the correct connection of 1-phase signal sources to the device in “single-ended” mode:

The single-phase signal sources
in “single-ended” mode

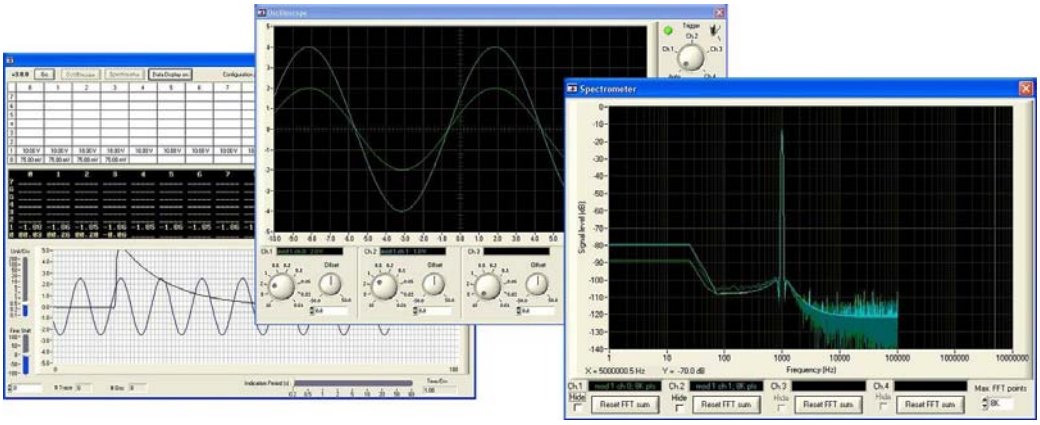


7. Software

Software of the QMBox10 devices consists of the following components:

- QMLab software suite
- Software development kit (SDK package)

7.1. QMLab software suite



The QMLab software suite is a universal software tool for working with QMBox devices. It allows performing most standard tasks within measurement automation.

The QMLab suite allows you to start work immediately after the device is connected: acquire, process, visualize and save the already calibrated data converted to the required measurement units without help of programmers or metrologists.

The QMLab suite includes:

- data recorder;
- oscilloscope;
- spectrum analyzer;
- primary data processing unit

Primary data processing can include calibration, averaging, calculation of the signal rate of change, etc.

For further processing data is saved in standard text and binary formats suitable for conventional and specialized data processors (Excel, MathLAB, Cool Edit pro, etc.).

A detailed description of the QMLab suite is given in the **"QMLab User Manual"** document that can be found on the site www.RTechElectronics.com and on the CD supplied with the device.

7.2. Software development kit

Apart from the complete QMLab software suite, the QMBox10 delivery set includes an SDK package, which is software and documentation designed for users who would like to create their own applications for working with the device. This software consists of function libraries (API) and examples of software development.

The user has a possibility to create full-blown applications using just a limited number of library functions. These library functions are written so that even an inexperienced programmer who is not well-versed in multithreaded and object-oriented programming can work with the device. A more detailed description of the software development kit is given in the **"QMBox Programming Guide"** document that can be found on the site www.RTechElectronics.com and on the CD supplied with the device.